Landscape and Urban Planning 125 (2014) 65–75

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Research Paper

Benefits of clearing forest plantations to restore nature? Evidence from a discrete choice experiment in Flanders, Belgium

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HIGHLIGHTS

- We investigate WTP for nature restoration compared to forest plantations.
- Preference heterogeneity is explored through mixed logit and latent class models.
- People prefer landscape diversity, high biodiversity and good site accessibility.
- We find support for small-scale conversions of forest plantations.
- We find no distance-decay, but a significant effect of perceived substitution.

ARTICLE INFO

Article history:
Received 14 August 2013
Received in revised form 27 January 2014
Accepted 2 February 2014
Available online 6 March 2014

Keywords:
Discrete choice experiment
Forest conversion
Nature restoration
Preference heterogeneity
Nature valuation

ABSTRACT

To ensure the long-term survival of its most valuable and threatened habitats, the European Union (EU) is committing its Member States to develop a network of protected areas. Flanders (northern Belgium) is a highly urbanised region, where natural environments are scarce. Policy-makers are converting existing forest plantations (mostly former coniferous plantations) into natural areas to comply with the EU requirements about nature restoration and satisfy the growing demand for recreation and amenity spaces.

The conversion of forest plantations into higher value nature, however, sometimes meets public opposition because it often involves clearcuts and landscape modification. Regional planning authorities are looking for case studies demonstrating which type of nature restoration is valued and thus supported by citizens. Past valuation studies show that personal, site-specific and spatial characteristics influence preferences. However, little is known about the relative importance of such factors.

We conduct a discrete choice experiment to investigate preferences for nature restoration scenarios that involve forest conversion. A mixed logit and a latent class model are estimated and the influence of socio-demographic characteristics is explored. Willingness-to-pay (WTP) estimates are elicited. Though people generally prefer the forest habitat type, our results suggest that public support exists for converting forest plantations if this contributes to increasing landscape diversity and species richness. Based on our findings, we recommend small scale cuts. This in order to gently open the landscape, assist the natural regeneration process and help current species adapt to that landscape modification.

1. Introduction

To ensure the long-term survival of Europe's most valuable species and habitats, European Union (EU) Member States are committed to designate protected areas and considerable funds are allocated with the aim to protecting biodiversity in Europe. Several nature restoration projects are being implemented through the EU Birds and Habitats Directives and Natura 2000,

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http://dx.doi.org/10.1016/j.landurbplan.2014.02.006
0169-2046/

a network of protected areas throughout the EU. Meeting such EU targets is not an easy task in densely populated and urbanised areas.

Flanders (northern Belgium) is a highly urbanised region with a strongly fragmented landscape, where natural environments remain scarce. Most notably, forests represent 13.1% of the Flemish territory (177,424 ha) and are mostly scattered in pieces of less than 1 ha. Biodiversity is consequently threatened. About half of the plants and animals are "red-listed" species (INBO, 2014a). The loss of suitable habitats and the decline in environmental quality explain most of this negative trend.

To date, Flanders has 62 Natura 2000 areas (i.e. 166,187 ha or 12.3% of the territory). In addition, the Flemish Government committed itself, through the Flemish Decree for Nature Conservation, to implementing an effective ecological network via two initiatives: the Flemish Ecological Network ("VEN") and the Integral Interrelation and Support Network ("IVON").

This nature restoration effort involves turning many agricultural lands, plantations and woodlands back to heathland or native broadleaved forest. Existing research (Liekens et al., 2013) demonstrates public preferences for converting agricultural lands into nature areas in a similar context. Conversions to forests in particular are found to be preferred over other habitat types, such as wetland or heathland. However, Flanders is witnessing a trend of clearing forests (especially coniferous plantations introduced in the late 19th century) to restore heathland (Verheyen, Lust, Carnol, Hens, & Bouma, 2006). Nowadays, this unique habitat is one of the most threatened habitats in Belgium (Maes, van Dyck, Vanreusel, & Cortens, 2003) and accommodates a number of endangered species. The willingness to pay (WTP) estimates from Liekens et al. (2013) suggest that converting forest to heathland might result in a loss of societal value. However, it is unclear if one can extrapolate those results (preferring forest over heathland) to the conversion of forest plantation into higher value nature areas.

Understanding public preferences for converting production-oriented forest stands back to heathland or native broadleaved forests is a complex matter that deserves attention and the careful consideration of its implications on land use planning decisions. Forest conversion involves clearcutting practices that traditionally meet strong opposition from the public (Bradley & Kearney, 2007; Ribe & Matteson, 2002). The size of the logged area is particularly influential. Past studies show that public opinion of small clearcut areas is usually more positive than of larger areas (Bradshaw, 1992; Tahvanainen, Tyrväinen, Ihalainen, Vuorela, & Kolehmainen, 2001). Bliss (2000) points out that people's opinion about forest clearcutting is also based on the perceived ecological benefits.

This case study has the double objective (i) to contribute to the limited literature related to public preferences for nature restoration involving forest conversion, and (ii) to inform policy-makers on how to design community-supported restoration policies. We address this question in response to a strong demand for literature on landscape preferences from policy-makers and regional planners. A discrete choice experiment (DCE) is conducted to elicit preferences for hypothetical restoration scenarios. WTP estimates are derived by means of mixed logit and latent class models that control for taste heterogeneity.

The remainder of this paper is organised as follows: the next section presents the rationale behind preferences for nature restoration. Section 3 briefly introduces the case study. Then, Section 4 describes our methodology and Section 5 outlines our modelling approach. The results of the estimated models and consequent marginal WTP are presented in Section 6. Section 7 discusses those results and Section 8 concludes the paper.

2. Public preferences for nature restoration

Public preferences are heterogeneous (Swallow, Weaver, Opaluch, & Michelman, 1994). Environmental valuation studies typically account for this by including environmental (Adamowicz, Nelson, Naidoo, Polasky, & Zhang, 2011), infrastructural (Brainard, Bateman, & Lovett, 2001; Roovers, Hermy, & Gulinck, 2002), spatial (Geoghegan, Wainger, & Bockstael, 1997; Johnston, Swallow, & Bauer, 2002), or individual parameters (Adamowicz, Swait, Boxall, Louviere, & Williams, 1997) to their econometric model. In our study, we investigate three dimensions of preference heterogeneity which, in turn, lead to different WTP: (i) site characteristics, (ii) individual-related characteristics, and (iii) off-site spatial characteristics.

2.1. Site characteristics

Site characteristics are not in essence a source of preference heterogeneity. However, WTP will vary across sites because of the diversity of site characteristics. When selecting environmental attributes for a DCE, priority must be given to demand-relevant, policy-relevant and measurable attributes (Blamey, Bennett, Louviere, Morrison, & Rolfe, 2002). In this context, three site characteristics are particularly important: biodiversity, habitat composition, and accessibility.

First, biodiversity is a crucial ecological characteristic and the subject of numerous valuation studies (Meyerhoff, Liebe, & Hartje, 2009; Xu, Lippke, & Perez-Garcia, 2003). As "biodiversity" encompasses a large number of concepts, we only approach it from a "species richness" viewpoint. Higher species richness is expected to positively affect preferences. Second, the mosaic of natural habitats that shapes the landscape also affects its valuation (Rambonilaza & Dachary-Bernard, 2007). Studies find public preferences for restoring broadleaved woodlands (Mill, van Rensburg, Hynes, & Dooley, 2007; Scarpa, Chilton, Hutchinson, & Buongiorno, 2000) or, on the contrary, native pinewood forests over other habitats (McMillan & Duff, 1998). The attachment to unique or traditional habitats may thus also influence landscape preferences. Note that, by contrast, relative preferences for heathland restoration are scarcely addressed in the nature valuation literature (Strange, Jacobsen, Thorsen, & Tarp, 2007).

Third, site characteristics that affect use values, and outdoor recreation in particular, strongly influence nature valuation (Stenger, Harou, & Navrud, 2009). Past studies reveal that users' WTP for the conservation of nature areas exceeds non-users' WTP (Hanley, Wright, & Adamowicz, 1998). WTP seems particularly correlated to the accessibility of natural areas (i.e. trails, car parking and facilities) (Watson, McFarlane, & Haener, 2004). Recent research shows, however, that attributes related to nature characteristics (e.g. water quality) may be preferred over accessibility (Perni, Martínez-Paz, & Martínez-Carrasco, 2012). In any case, site accessibility is expected to affect the recreational attractiveness of a nature area and deserves particular attention.

2.2. Individual-related characteristics

A common practice to account for individual taste heterogeneity is to include attitudinal and socio-demographic variables. Respondents' characteristics like age, gender, level of education and income are particularly helpful. They validate individual responses to WTP questions, and help limit biases when transferring values across populations and sites (Rosenberger, Needham, Morzillo, & Moehrke, 2012; Turner et al., 2003). Landscape preferences often find their origin in each individual's experience of nature, which can be approached by adding attitudinal variables. For instance, the importance a respondent attaches to adjacent nature when they

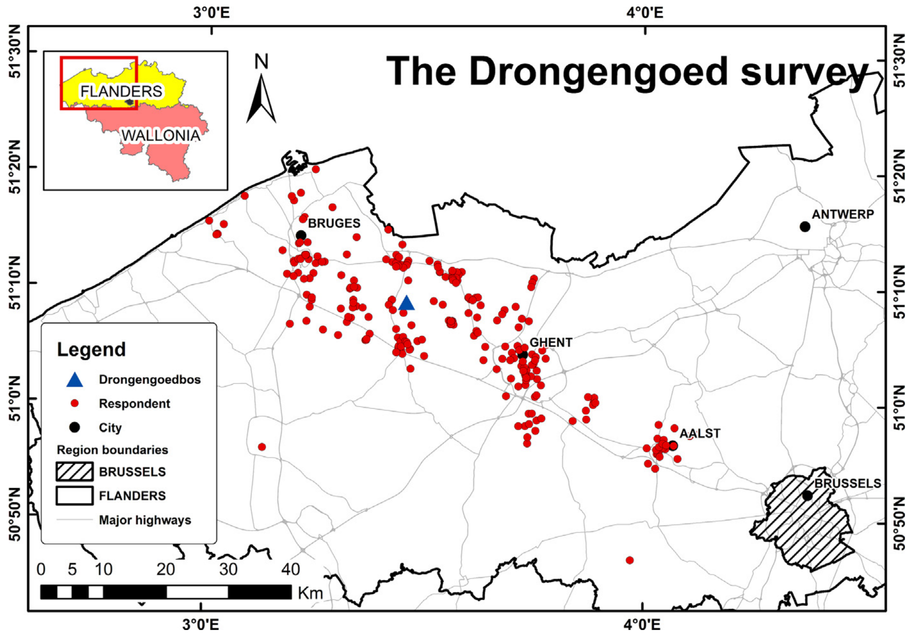

Fig. 1. Locating the site and the survey respondents.

moved to their current residence location may provide insights on their consideration for a certain type of landscape. In particular, Milon and Scrogin (2006) observe that respondents with pro-environmental attitudes show a higher WTP for nature restoration than other respondents.

2.3. Off-site spatial characteristics

Off-site spatial characteristics refer to the geographical context of the site under valuation. Two spatial factors – distance and substitution – are particularly influential in nature valuation (Pellegrini & Fotheringham, 2002). WTP tends to decline with the geographical distance between the respondent and the nature site up to a threshold where they may even be no longer willing to pay (Loomis, 2000). The substitution effect refers to the availability of alternative sites (substitutes) within a certain spatial scale. In theory, the larger the supply of substitutes, the lower the WTP for restoring one nature site, ceteris paribus (Loomis, Gonzalez-Caban, & Gregory, 1994).

3. The Drongengoed case

The case study presented in this paper relies on a survey conducted at the "Drongengoed", Flanders (Fig. 1). With a total size of 860 ha, this site is the largest one-piece nature area in the province of East-Flanders. Protected for a large part under the Habitat Directive, this site is rich in biodiversity. A rare collection of sedges (*Carex* spp.), heath milkwort (*Polygala serpyllifolia*) and waxcap mushrooms (*Hygrocybe* spp.) indicate species-rich grasslands. Uncommon butterflies, such as the white admiral (*Limenitis camilla*) or rare syrphid flies can also be observed and indicate good quality forests.

Most of the Drongengoed was originally covered by moor and heather until its conversion to farmland in 1746. Due to hard clay soils, most of the site was not suitable for crops and was afforested. Nowadays the Drongengoed is publicly accessible and often visited by walkers and cyclists for recreation.

"Natuurpunt" (a Flemish NGO for nature conservation) is busy restoring this site to its original state, which makes the Drongengoed an ideal place to investigate preferences for different nature restoration scenarios.

4. Methods

4.1. Nature valuation through discrete choice experiments (DCEs)

DCE is a preference elicitation method introduced by Louviere and Hensher (1982) and commonly used in nature valuation (Hoyos, 2010). Information gathered through a survey allows modelling preferences for hypothetical nature restoration scenarios. Respondents are generally presented several choice sets. For each choice set they are asked to choose between two or more alternatives described by attributes. At least one attribute of the alternative is systematically varied across respondents so that preference parameters of an indirect utility function can be inferred (Carson & Louviere, 2011). This characteristic makes DCEs superior to other methods (e.g. contingent valuation) in understanding the trade-offs that respondents are willing to make among attributes. DCEs are also popular due to their capacity to elicit the total economic value (TEV), including use and non-use values, of hypothetical scenarios (Pearce & Özdemiroglu, 2002).

DCEs rely on McFadden's Random Utility Maximisation theory (1974), which states that a respondent's utility function comprises a deterministic, observable component (V) and a stochastic, unobservable component (ε):

$$U_{ijt} = V_{ijt} + \varepsilon_{ijt} = \beta X_{ijt} + \eta_i X_{ijt} + \varepsilon_{ijt}, \qquad (1)$$

where U_{ijt} represents the utility a respondent i derives from choosing alternative j on choice situation t, X_{ijt} is a vector of k observed attributes for the site in question (k being the number of attributes), β is the vector of preference parameters associated with the attributes, η_i is a vector of k standard deviation parameters, and ε_{ijt} is a stochastic error term, independently and identically distributed (iid) according to a Gumbel distribution (Louviere, Hensher, & Swait, 2000). One choice set comprises of several alternatives (nature restoration scenarios). Choosing one alternative over the others implies that the utility of the chosen alternative exceeds the utility derived from the other alternatives (Ben-Akiva & Lerman, 1985).

Respondents' preferences are generally estimated through maximum likelihood in logit models (Ben-Akiva & Lerman, 1985). Parameter estimates are derived from the log-likelihood

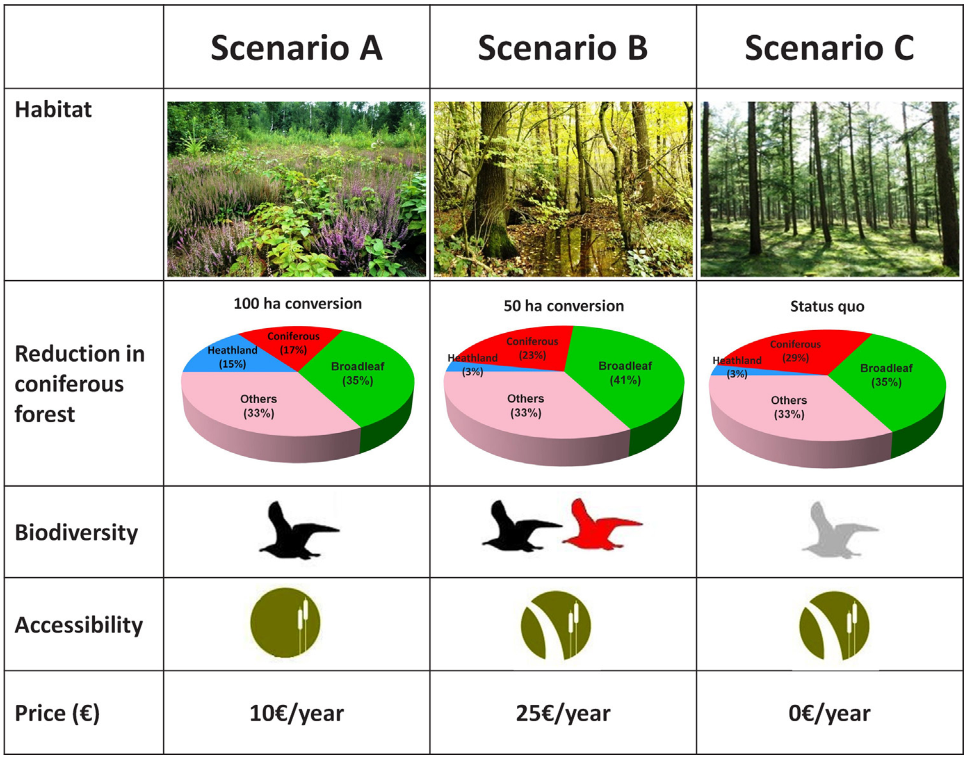

Fig. 2. Example of choice set.

function associated with the logit model, and accounting for three dimensions of information: individuals, choice sets and choice alternatives. By looking at the choices made by individuals when some attribute levels vary and at the same time looking at the price associated with this particular scenario of change, one can derive marginal values for each attribute when moving from the "status quo" (or initial level) of the attribute to the final level of this attribute. This gives the marginal WTP_i (also called implicit price) of a respondent i for such a change in that attribute (Louviere et al., 2000):

$$WTP_i = -\frac{\beta_{attribute}}{\beta_M} \quad (2)$$

where β_M is the marginal utility of income (assumed to be equal to the negative of the coefficient of the monetary variable). Mean marginal WTP can then be estimated by taking the average over the sample distribution of WTP_i coefficients.

4.2. Experimental design

In the present case, respondents have to choose between three unlabeled nature restoration scenarios, one being the "status quo" (Fig. 2). The status quo depicts the current situation: 250 ha conifers, 310 ha broadleaves, 25 ha heathland and 275 ha other lands (pasture, arable land, peat, poplar). Currently, there are only few species present and the density of footpaths is considered as sufficiently good within the area. For the status quo ("do nothing") scenario, price remains zero. To facilitate respondents' understanding of the survey context, a short description of the situation is provided. Attributes and attribute levels used through the DCE are also explained by means of a legend briefly summarising their meaning and shown prior to the DCE exercise.

The choice sets vary according to four attributes: change in habitat (increase in broadleaves or heathland), size of the coniferous forest conversion, species richness and accessibility. Note that "Species richness" is presented in a general and non technical way to remain at the landscape level and to prevent overwhelming the respondent with expert, taxonomical references to certain species (Liekens et al., 2013). For example, a respondent can more easily realise about the value of a site thanks to the presence of "rare species" rather than specifying "presence of Eurasian Sparrowhawk (*Accipiter nisus*)". For decision-makers, knowing that respondents may be willing to pay for "rare species" is valuable information that can lead to specific policies supporting the conservation of "red-listed" endangered species (INBO, 2014b).

A cost attribute is included to conduct the WTP analysis (Table 1). The payment mechanism used here is an annual tax exclusively designed for the restoration of the Drongengoed. The Drongengoed case is part of a series of similar DCEs carried out by the VITO-RMA team across different sites in Flanders. The original survey design and the selected attributes were tested and described in Liekens et al. (2013). In discussion with local experts, we adapted the original survey to focus on specific characteristics of the area and potential forest conversion scenarios.

The full factorial experimental design produces 144 (=$2^3 \times 3 \times 6$) possible combinations. Requiring respondents to choose among

Table 1
Attributes and levels used in the choice sets.

Attributes	Levels	No. of levels
Habitat	Conversion from coniferous forest to heathland Conversion from coniferous forest to broadleaved forest	2
Species richness	More species (common species) More species (common and rare species)	2
Reduction in coniferous forest	50 ha, 100 ha, 200 ha	3
Accessibility	Good Poor	2
Price (€)	10, 25, 50, 75, 125, 200	6

so many alternatives would be cumbersome and intellectually demanding. Therefore, we use a D-optimal main-effects fractional factorial design (Louviere et al., 2000) to obtain 24 choice sets. These choice sets are subsequently split into 4 blocks of 6 choice sets. Respondents are randomly allocated to one of the 4 blocks. The design and block definition steps are performed using SAS 9.2 and following Kuhfeld's (2010) method.

Kuhfeld's method is particularly adapted to designing complex DCEs in which, for instance, attributes do not have equal numbers of levels, and interactions exist within each alternative. Such designs are usually non-orthogonal but they are efficient as they minimise the variances and covariances of the parameter estimates.

4.3. Data collection

The survey questionnaire contains three parts: (i) general questions about respondents' opinion on environmental issues, perception of nature and recreational habits; (ii) the DCE; (iii) demographic and follow-up questions (e.g. "How would you judge the complexity of the choice sets?").

Data were collected through a web-based questionnaire. Despite its usual low response rate, we chose this method because of its practicality in presenting graphical DCE and its potential for reducing data entry errors. Furthermore, its capacity to rapidly reach a large number of respondents at low cost was the central argument for preferring this method to others, such as computer-aided face-to-face interviews.

The survey was managed by a marketing firm, using a panel of Flemish residents representative of the population in terms of age, sex, education and income. From June 2011 to mid-August 2011, the firm repeatedly sent the questionnaire to its panel members until a desired number and representative mix of responses was reached.

Out of the 2203 panel members eventually selected, 440 responses were obtained, resulting in a response rate of 20%. Past studies using web-based surveys in Europe yield comparable response rates (e.g. Bliem, Getzner, & Rodiga-Laßnig, 2012; Deutskens, De Ruyter, Wetzels, & Oosterveld, 2004). After removing all 197 incomplete or inconsistent responses and 26 protest zero bidders, the final data set included 217 responses, resulting in 1302 choice observations. Protest zeros are identified as respondents who picked the opt-out alternative in all six choice sets and justified it each time in the subsequent motivation assessment question by stating "I already pay too many taxes".

4.4. Descriptive statistics

The main socio-demographic characteristics of the sample are presented in Table 2. The age, gender and household size characteristics of the survey sample match those of the target population (Flanders, ~6.35 Mio citizens). We observe however a sampling error for certain characteristics. There is an over-representation of employed respondents, with a higher level of education and a higher income. This may indicate a potential risk of self-selection bias to be considered when interpreting the results.

Most of the respondents have prior knowledge of the site and have at least recreated there once in their lifetime. The majority of the people (61.8%) think that active environmental actions are needed but only 24.4% declare to be actually member of an "eco-friendly" NGO. Walking is by far the most popular outdoor recreational activity, followed by cycling. For 60% of the respondents, nature proximity was decisive when choosing their home location. The majority feels sufficiently surrounded by nature. By road, respondents live on average 19.7 km away from the site, although values range from 2.7 to 66 km.

Table 2
Socio-demographic profile of the respondents.

Variable	Sample average	Flemish population average[a]
Gender (% of males)	53.7	49.4
Age (mean age in years)	50.7	46.5[c]
Household size (mean)	2.6	2.4
Education (% of higher education level)	47.7	27.1
Monthly household net income (€)	2431.8	2040.3
Job status (% of employed[b] people)	53.9	43.0
Member of an eco-friendly NGO (%)	24.4	–
Knew the Drongengoed before (ex ante knowledge) (%)	66.4	–
Had already recreated at least once at the site (%)	88.7	–
Believe that active nature protection/management is needed (%)	61.8	–
Nature proximity was decisive when choosing home location (%)	60.0	–
Satisfied with nature density within 5 km[d] (%)	71.0	–
Sample size, N	217	6,350,765

[a] Belgian Federal Government (2013).
[b] Actively working (not student, not jobless);
[c] Based on the same population segment as the one reached in the survey, i.e. 15–84 years old.
[d] Based on scores 5, 6 or 7 on a seven-point Likert scale ranging from 1, "strongly disagree" to 7, "strongly agree".

5. Empirical approach

We estimate Eq. (1) using a mixed logit (MXL) model, then a latent class model (LCM). Stated preference literature indicates the need to better represent heterogeneous preferences in choice modelling (Colombo, Hanley, & Louviere, 2009). Combining MXL and LCM approaches offers the advantage to explore preference heterogeneity from two different angles.

The mixed logit (MXL) model is a generalisation of the standard multinomial logit model that allows controlling for unobserved taste heterogeneity (Hensher & Greene, 2003). By attaching a random component to the model attributes, the MXL allows preferences to vary across respondents. Then, by adding respondent-specific variables (e.g. socio-demographics) in interaction with the model attributes, it is also possible to control for observed, individual heterogeneity, and hence improve the fit of the model (Train, 2003).

Apart from the *Price* attribute, which has six different values, all choice attributes included in the estimations are dummy-coded (Table 3). An alternative is to use effects coding (Bech & Gyrd-Hansen, 2005). Dummy coding was however chosen for its simplicity of interpretation and because a trial with effects coding showed no significantly different behaviour in the model variables.

An alternative specific constant (ASC) is included in the model. An ASC captures the variations in choices that cannot be explained by the attributes or by other covariates included in the model. It reflects the effect of choosing one scenario over the option of doing nothing. Here, the ASC conveys the change in utility affecting a respondent when he chooses to leave the status quo (current situation) for a situation with 50 ha of coniferous trees converted to heathland, more common species and no reduction in the accessibility level. Therefore, the ASC captures both the utility of moving

Table 3
Model variables.

Attributes	Description
ASC	Dummy. 1 if respondent willing to move away from the status quo, 0 if they prefer the status quo
Price	Cost of the different scenarios
Site variables	
Broadleaf	Dummy. 1 if switch to broadleaf habitat, 0 if switch to heathland
Size100	Dummy. 1 if coniferous forest decreased by 100 ha, 0 if by 50 ha
Size200	Dummy. 1 if coniferous forest decreased by 200 ha, 0 if by 50 ha
Broadleaf × Size100	Interaction term between *Broadleaf* and *Size100*
Broadleaf × Size200	Interaction term between *Broadleaf* and *Size200*
Rare species	Dummy. 1 if more species, including rare ones, 0 if more common species
No access	Dummy. 1 if poor accessibility to the area, 0 if good accessibility
Individual-related variables	
High income	Dummy. 1 if income > €3500, 0 otherwise
Retired	Dummy. 1 if respondent's age ≥ 65 years, 0 otherwise
Higheduc	Dummy. 1 if bachelor or higher degree, 0 if High school degree or lower
Gender	Dummy. 1 if male, 0 if female
Visitor	Dummy. 1 if respondent has already visited the site, 0 otherwise
Homenat	Dummy. 1 if nature proximity was crucial to choose home location, 0 otherwise
Ecofriendly	Dummy. 1 if member of an "eco-friendly" NGO (e.g. WWF), 0 otherwise
Off-site spatial variables	
Distkm	Road distance (in km) between respondent's home and the site
Natprox5km	Dummy. 1 if individual feels sufficiently surrounded by nature in his 5 km vicinity, 0 otherwise

away from the status quo and the utility of the base level of the dummy-coded attributes[1] (Mark & Swait, 2004).

As mentioned in Section 4.2, the proportion of each type of habitat at the study site is different. Heathland, for instance, is much scarcer than broadleaf. A 50 ha decrease of coniferous trees resulting in a 50 ha increase in heathland represents a 200% increase of heathland compared to the current situation, while the same increase in broadleaves only represents a 16% increase. By interacting the *Broadleaf* variable with the dummy variables *Size100* and *Size200*, we take into account that the WTP for one ha of broadleaved forest may not be the same as for one ha heathland.

Following the methodology recommended by Hensher and Greene (2003), a Lagrange multiplier test is carried out to assist in the establishment of candidate random parameters. All attributes but the *Price* are tested and show preference heterogeneity, except the interaction term between *Broadleaf* and *Size200* which failed the test and is thus kept fixed.

Price is also kept fixed. Keeping the price attribute fixed is common practice in nature valuation (Colombo et al., 2009; Train, 2003), although recent studies recommend the use of models that control for cost heterogeneity, like WTP-space models (Hole & Kolstad, 2012). These models, however, typically make the estimation of WTP less straightforward. We consider that LCM methods offer a good alternative to account for heterogeneous preferences for income.

[1] This is entirely due to the dummy-coding used for the attributes (see Bech & Gyrd-Hansen, 2005). Using effects coding for the "non-ASC" variables allows the ASC coefficient to purely capture the (dis)preference for the status quo. We also tested the model using effects coding and the estimated parameter of the ASC remained positive and significant.

We assume a normal distribution for the random coefficients because some respondents are expected to have positive preferences and some others negative preferences regarding the different attributes of the site (Carlsson, Frykblom, & Liljenstolpe, 2003). We apply Stata's "mixlogit" command (Hole, 2007) with 1000 Halton draws to estimate the MXL coefficients by simulated maximum likelihood. The following expression depicts the utility function that an individual i gets from alternative j at choice situation t (Scarpa, Thiene, & Marangon, 2008):

$$U_{ijt} = \begin{cases} V(ASC, X_{ijt}, \eta_i, \beta) + \varepsilon_{ijt}, & \text{if } j = 1, 2; \\ V(X_{ijt}, \eta_i, \beta) + \varepsilon_{ijt}, & \text{if } j = \text{status quo}; \end{cases} \quad (3)$$

where *ASC* is a dummy variable equal to 1 if the respondent is willing to move away from the status quo and equal to 0 in case they prefer the status quo, X_{ijt} is a vector of choice attributes, η_i is a vector of individual-specific standard deviation parameters, β is the vector of preference parameters associated with the attributes, and ε_{ijt} is an iid stochastic error term.

To control for observed heterogeneity, we estimate an extended MXL model with the inclusion of interacted variables. Since site characteristics are already integrated as model attributes, the focus here is on individual and spatial characteristics. We add four socio-demographic variables (*High income*, *Retired*, *Higheduc* and *Gender*) and three attitudinal variables (*Visitor*, *Homenat* and *Ecofriendly*) in interaction with the attributes. Next, two spatial variables are also added: *Distkm*, the road distance separating each respondent's residence from the site and calculated using the ArcGIS 10 GIS package, and *Natprox5km*, a variable on the perceived nature proximity in a 5 km radius. *Natprox5km* is based on a question asked during the survey. This parameter controls for a possible substitution effect by looking into people's satisfaction about the density of nature within 5 km from their residence. "Nature" here refers to the following types of landscape: forest/woodland, heathland, peatland, rivers and marshes. Other potential land cover types are negligible in the present context.

We complete our analysis by estimating a latent class model (LCM). LCMs offer a useful alternative to MXLs for their capacity to capture preference heterogeneity in case it follows complex, multimodal distributions (Scarpa & Thiene, 2005). Compared to MXLs (using continuous distributions), LCMs assume finite mixing distributions. Because they help define groups of respondents, LCMs are able to identify potential winners and losers of a particular policy adoption. Combining the merits of both MXL and LCM approaches is thus particularly relevant for capturing preference heterogeneity from two different angles.

6. Results

6.1. MXL model

The MXL results are reported in Table 4. The ASC term is positive and significant. This suggests that respondents positively value a nature restoration scenario that would convert 50 ha of the current coniferous tree cover to heathland, add more common species and maintain the accessibility level.

Most random parameters expected to influence individual's preferences, are statistically significant. Concerning changes in habitat composition, preferences diverge as expected in accordance with the size of the converted area. Respondents seem to prefer a medium change of 100 ha from coniferous forest to broadleaves over smaller (50 ha) and larger changes (200 ha) to broadleaves.

The situation is different for heathland. A small (50 ha) conversion from coniferous forest to heathland is preferred over a medium (100 ha) or a large (200 ha) one. No significant difference is found, however, between a 200 ha and a 100 ha conversion to heathland.

Table 4
Parameter estimates based of the mixed logit model (1000 Halton draws).

Attributes and interactions	MXL model		Interacted MXL model	
	Mean (SE)	Std. dev. (SE)	Mean (SE)	Std. dev. (SE)
ASC	2.495*** (0.269)		2.748*** (0.491)	
Price	−0.028*** (0.002)		−0.029*** (0.002)	
Rare species	0.126 (0.265)	2.948*** (0.319)	0.105 (0.253)	2.811*** (0.305)
No Access	−1.017*** (0.243)	2.332*** (0.257)	−1.041*** (0.238)	2.109*** (0.242)
Broadleaf	−0.906*** (0.3)	2.234*** (0.308)	−0.826*** (0.289)	2.107*** (0.304)
Size100	−0.647*** (0.218)	0.428 (0.623)	−0.594*** (0.217)	0.516 (0.512)
Size200	−0.828*** (0.284)	1.594*** (0.333)	−0.716*** (0.272)	1.370*** (0.336)
Broadleaf × Size100	1.333*** (0.397)	−0.952 (0.773)	1.183*** (0.393)	0.945 (0.68)
Broadleaf × Size200	0.413 (0.389)		0.302 (0.381)	
ASC × High income			0.340 (0.366)	
ASC × Retired			2.177*** (0.413)	
ASC × Higheduc			0.084 (0.285)	
ASC × Gender			−0.565 (0.281)	
ASC × Ecofriendly			2.236*** (0.36)	
ASC × Distkm			0.001 (0.012)	
ASC × Natprox5km			−1.224*** (0.322)	
Log-likelihood	−1065.4		−1018.7	
Pseudo R^2	0.161		0.138	
AIC	2160.8		2081.3	
BIC	2254.9		2219.3	
Observations	3906		3906	
Sample size	217		217	

*** 1% significance level.

We believe this indicates that respondents prefer smaller openings in the forest landscape or that they prefer more diversity in the habitat composition. Indeed, large clearings of coniferous forest reduce landscape variability.

Given that the public preference is to move away from the current situation, we want to know which restoration scenario is preferred. We test whether a restoration project favouring native broadleaves is preferred over heathland restoration. Our data demonstrate that respondents prefer a 50 ha conversion to heathland over a conversion to broadleaves ($z = -3.03$; $p = 0.002$). By contrast, respondents seem indifferent to larger conversion sizes.

Recalling that each randomised parameter is distributed normally, Table 4 presents their mean value together with a standard deviation coefficient. The standard deviation provides information on the variability in the preference for that parameter. Significant unobserved taste heterogeneity is thus attached to all random parameters, except *Size100* and *Broadleaf × Size100*.

6.2. Interacted model results

To control for preference heterogeneity, the individual-related and spatial variables outlined in Table 3 are added to the model as interacted terms. Note that the *Homenat* and *Visitor* interactions are not presented, as a lack of observations for these variables would considerably restrict the whole sample size (from 3906 to 2268). Since we are interested in explaining people's enthusiasm or opposition towards forest conversion scenarios, interactions are only made with the ASC. Including all interactions simultaneously is unrealistic because of multicollinearity issues.

6.2.1. Individual-related characteristics

Age was first tested as a continuous variable but showed no significant effect. By isolating retired people (≥65 years old), we observe that they attach a higher positive value to nature restoration compared to younger respondents. This positive relationship between age and environmental awareness is confirmed in the literature (Aminrad, Syed Zakaria, & Samad Hadi, 2011) and may be due to pensioners' higher time availability to enjoy nature. None of the three other socio-demographic variables (*High income*, *Higheduc* and *Gender*) show a significant influence.

As expected, members of a pro-environmental NGO (*Ecofriendly*) show a strong positive preference for nature restoration. Nature enthusiasts get a higher utility from the proposed scenarios. This finding confirms that it is important to account for respondents' attitude towards nature.

6.2.2. Off-site spatial characteristics

Surprisingly, distance (*Distkm*) is not significant. Suspecting a data problem, we used GIS to explore the spatial distribution of the respondents in various ways. Quadratic and logarithmic transformations of distance were also tested with no success. A possible explanation is that our respondents are mostly spread along a Bruges–Ghent–Aalst axis (Fig. 1), which may introduce spatial disturbance. Another reason for observing no distance-decay effect is that Flanders is a heavily urbanised region, with the highest density highway network in Europe. Nature sites are thus scarce but very accessible.

Alternatively, we observe that the perceived density of substitutes near people's home is detrimental to their preference for nature restoration scenarios. People satisfied with the amount of nature in their immediate environment (*Natprox5km*) show, ceteris paribus, a lower preference for improvements to the site. The proximity of green spaces provides close alternative recreational sites to the respondents. It is then logical that respondents are less willing to pay for restoring the Drongengoed, a place located farther than other options and that they are less likely to visit.

6.3. Latent class model (LCM)

We use the Stata "lclogit" command (Pacifico, 2010), which estimates the LCM through the Expectation-Maximisation (EM) algorithm. The EM algorithm guarantees numerical stability and convergence to a local maximum even when the number of latent classes is large.

The first necessary step in a LCM is to define the most appropriate number of classes. One common way to do that is by comparing goodness-of-fit statistics for a realistic number of potential classes.

Table 5
Criteria for the determination of the optimal number of classes.

Classes	Log likelihood	Parameters	AIC	BIC
MXL	−1109.26	9	2248.52	2343.25
2	−910.65	22	1865.31	1939.66
3	−870.19	35	1810.38	1928.67
4	−823.65	48	1743.3	1905.53
5	−798.83	61	1719.65	1925.82
6	−782.30	74	1712.59	1962.71

The Akaike information criterion (AIC) and Bayesian information criterion (BIC) are used for guidance and tend to support the option of a model based on four classes (Table 5).

However, as stated by Scarpa and Thiene (2005), this remains an arbitrary decision relying on the analyst's judgement. Before making a final decision, one should judge the significance of parameter estimates and the meaningfulness of the parameter signs. We finally choose to pursue the LCM analysis with three classes, as a model based on four classes presented a high number of insignificant variables and was making certain classes hardly interpretable.

The results of the 3-class LCM model are reported in Table 6. Due to their high significance in the MXL-interacted model, *Retired*, *Ecofriendly* and *Natprox5km* are used to help inform class membership. The mean highest posterior probability of the model is 0.941, which suggests that most of the underlying taste heterogeneity patterns are captured. Compared to the MXL (Pseudo-$R^2 = 0.161$) and interacted-MXL models (0.138), the 3-class LCM model presents a better goodness-of-fit (0.392), which supports the added-value brought by this method. Pseudo-R^2 coefficients above 0.2 generally indicate good model fit (Louviere et al., 2000).

Class 1 is the largest class (38.4% of the respondents). Compared to the two other classes, we observe that the ASC is not significant, suggesting that these respondents are indifferent about nature restoration. Class 1 respondents seem to have strong negative preferences for a reduction in the site accessibility level and are more cost averse than the other groups. As *Natprox5km* is also positive and significant, Class 1 may represent recreationists facing the substitution effect.

Class 2 is the second largest class (35%). As the ASC is positive and significant, Class 2 respondents are highly supportive of any restoration scenario. Other parameter estimates are in line with the MXL findings and even bring new information. *Rare species*, previously observed insignificant, is now positive and significant, such as expected. The large preference heterogeneity attached to that attribute is now explained: half of the respondents attach positive preferences to it while the rest seem to be indifferent. "Nature enthusiasts" are more likely to be part of that class since *Ecofriendly* is positive and significantly larger than for the two other groups.

Class 3 represents the "moderate nature supporters": respondents who are supportive of the nature restoration scenarios but are more reluctant to pay for them than respondents from Class 2. Class 3 respondents show no clear preferences about landscape composition but are, on the contrary, significantly more concerned about species richness than other respondents. Interestingly, Class 3 respondents consider a decrease in the accessibility level as detrimental when Class 2 respondents show no preference. This may indicate a larger proportion of site visitors in Class 3 and of non-users in Class 2.

Respondents with similar preferences are thus endogenously allocated to "latent classes" by the EM algorithm (Pacifico, 2010). A respondent is assigned to class c if this respondent's highest posterior membership probability is obtained for class c. Once allocated to a class, respondents' socio-demographics can be calculated.

By comparing socio-demographic differences across classes (Table 7), we observe that Class 3 contains on average significantly more women than Class 1 and 2 (comparison based on a series of two-sample t-tests run by excluding each time one class). Similarly, Class 2 is on average significantly older than the rest. Class 2 contains as well many more members of pro-environmental NGOs.

Table 7
Socio-demographic profiles of the respondents for each latent class.

	Class 1	Class 2	Class 3
Sample size, N	84	74	59
Gender (% of males)	58.3 (5.4)	60.8 (5.7)	44.1 (6.5)
Age (mean age in years)	50.5 (1.5)	56.9 (1.68)	40.9 (1.7)
Education (% of higher education level)	41.7 (5.4)	44.6 (5.8)	59.3 (6.5)
Monthly household net income (€)	2565.5 (108.6)	2315.9 (101.8)	2474.6 (118.2)
Member of an eco-friendly NGO (%)	11.9 (3.6)	44.6 (5.8)	22.0 (5.4)
Distance to the site (km)	19.7 (1.3)	19.4 (1.2)	19.4 (1.6)
Satisfied with nature density within 5 km (%)	80.9 (4.3)	66.2 (5.5)	62.7 (6.4)

Table 6
LCM estimates for nature restoration attributes based on three classes.

	Class 1 "Substitution effect"	Class 2 "Nature enthusiasts"	Class 3 "Moderate nature supporters"
Utility function			
ASC	0.585 (0.402)	4.125*** (0.446)	3.423*** (0.633)
Rare Species	−0.160 (0.32)	0.351** (0.139)	0.838*** (0.306)
Noaccess	−0.920*** (0.35)	−0.191 (0.158)	−1.369*** (0.432)
Broadleaf	0.029 (0.48)	−0.671*** (0.259)	0.016 (0.449)
Size100	−0.081 (0.46)	−0.903*** (0.216)	−0.141 (0.366)
Size200	−1.066 (0.66)	−0.535** (0.236)	−0.430 (0.539)
Broadleaf × Size100	−0.366 (0.746)	1.168*** (0.444)	1.125 (0.694)
Broadleaf × Size200	1.271 (0.866)	0.293 (0.348)	0.311 (0.73)
Price	−0.066*** (0.01)	−0.007*** (0.002)	−0.037*** (0.004)
Class membership variables: socio-demographics			
Constant	−0.248 (0.4)	−0.759 (0.489)	
Retired	10.604 (314.1)	12.606 (314.101)	
Ecofriendly	−0.589 (0.582)	1.459*** (0.558)	
Natprox5km	0.914** (0.451)	0.249 (0.523)	
Class share (%)	38.4	35.0	26.6
Observations	3906		
Sample size, N	217		
Log likelihood	−869.97		
Pseudo R^2	0.392		

*** 1% significance level, ** 5% significance level.

Table 8
Mean marginal WTP estimates (€/household) with Krinsky–Robb 95% confidence intervals.

Attributes	Standard MXL model	Interacted MXL model	Latent class model Class 1	Class 2	Class 3	Weighted
ASC	88.0 (73.3; 104.1)	94.8 (63.6; 128.7)	9.5 (−7.0; 20.5)	667.3 (426.3; 1422.2)	99.5 (80.3; 119.1)	263.7 (167.9; 537.3)
Rare species	4.4 (−14.2; 23.2)	3.6 (−13.5; 21.3)	−2.4 (−9.0; 4.8)	53.1 (1.0; 128.8)	22.6 (9.4; 37.9)	23.7 (−0.6; 57.0)
No Access	−35.8 (−53.6; −18.6)	−35.9 (−53.6; −19.8)	−13.6 (−23.1; −4.6)	−17.5 (−95.6; 27.3)	−41.5 (−62.7; −22.6)	−22.4 (−59.0; 1.8)
Broadleaf	−32.0 (−53.6; −11.1)	−28.5 (−48.2; −9.4)	0.02 (−15.8; 14.6)	−103.6 (−280.0; −6.2)	−0.6 (−20.0; 22.5)	−36.4 (−109.4; 9.4)
Size100	−22.8 (−39.9; −7.4)	−20.5 (−36.8; −5.4)	−2.4 (−19.7; 11.2)	−149.0 (−374.7; −69.2)	−4.0 (−16.7; 8.1)	−54.1 (−143.1; −17.8)
Size200	−29.2 (−49.5; −9.2)	−24.7 (−44.2; −6.9)	−18.3 (−40.9; −1.5)	−90.4 (−265.0; −11.8)	−15.0 (−39.1; 10.4)	−42.7 (−118.8; −1.9)
Broadleaf × Size100	47.0 (18.6; 76.9)	40.8 (15.1; 70.3)	−4.1 (−28.3; 26.4)	171.6 (36.9; 473.7)	30.3 (2.3; 58.0)	66.6 (2.7; 191.3)
Broadleaf × Size200	14.6 (−13.3; 41.8)	10.4 (−15.9; 36.9)	20.3 (−1.6; 46)	40.9 (−79.5; 196.0)	13.4 (−18.9; 44.2)	25.7 (−33.5; 98.0)
Interactions						
High income		11.7 (−13.4; 36.2)				
Retired		75.1 (47.8; 103.8)				
Higheduc		2.9 (−16.9; 23.1)				
Gender		−19.5 (−39.3; −0.7)				
Ecofriendly		77.2 (53.4; 103.6)				
Distkm		0.03 (−0.8; 0.9)				
Natprox5km		−42.2 (−65.8; −20.7)				

Finally, Class 1 shows a significantly higher proportion of respondents satisfied with the density of nature in their neighbourhood and consequently more prone to experience the substitution effect. Other socio-demographic characteristics do not show significant differences across classes.

6.4. Marginal WTP values

Table 8 reports the marginal WTP values calculated for nature restoration scenarios at the Drongengoed. The Krinsky–Robb method (parametric bootstrapping with 5000 repetitions) is used to construct the WTP confidence intervals.

In the standard MXL model, respondents are willing to pay €88 for a "standard change" (a 50 ha conversion from conifers to heathland, with more common natural species and sufficient accessibility). By contrast, a 50 ha conversion towards more broadleaves would only be worth €56. As expected, the respondents clearly value the accessibility of the area: a reduction in the number of footpaths induces a €35.8 drop in their WTP.

Respondents would be willing to pay €65.2 (=€88 – €22.8) to leave the current situation for a landscape with a 100 ha increase of heathland and €58.8 for a 200 ha increase of heathland. A larger conversion seems thus less appreciated. We tested for the presence of a significant difference of WTP for a switch from 100 ha to 200 ha of heathland and the WTP values did not diverge ($\chi^2 = 0.00$, $p = 0.95$). This suggests a decreasing marginal utility function for a conversion to heathland up to a certain extent (+100 ha or +400%), together with opinion divergences when considering larger changes (+200 ha or +800%).

Respondents would be willing to pay €80.2 (=€88 – €32 – €22.8 + €47) to modify the current habitat composition towards an additional 100 ha of broadleaves but only €41.4 for a 200 ha conversion to broadleaves. A test confirms that the WTP differs significantly between a 100 ha and a 200 ha increase in broadleaves ($\chi^2 = 10.95$, $p = 0.001$). This suggests a reverse *U*-shaped WTP curve for conversions to broadleaf.

Comparing heathland and broadleaf conversions, respondents would pay €32 less for broadleaf cover in the case of a 50 ha conversion, €15 more for broadleaf in the case of a 100 ha conversion, and again €17.4 less for broadleaf in the case of a 200 ha switch.

The interacted-MXL model confirms the results of the MXL model and adds information about the influence of certain socio-demographic characteristics. *Retired* and *Ecofriendly* respondents demonstrate significantly higher WTP (+€75.1 and +€77.2, respectively) than the rest. By contrast, respondents affected by nearby substitutes (*Natprox5km*) show significantly lower WTP (−€42.2) for restoring nature at the site.

The LCM model presents WTP results that diverge substantially across classes. Class 1 respondents show low support to nature restoration, which can be ascribed to the substitution effect. Class 2, on the contrary, shows very high WTP to support nature restoration. The high proportion of nature enthusiasts (44.6%) in that class could explain such large figures. Class 3 produces WTP results in line with the two MXL models. By weighting the WTP figures obtained for each class according to their corresponding class membership probability, we obtain WTP estimates that correct for three different groups of preferences. The weighted results show particularly high WTP for moving away from the current situation (€263.7). One should, however, cautiously consider these last results as many variables do not appear significant (Table 6).

7. Discussion

This case study contributes to the limited literature about public preferences for nature restoration that involve the conversion of existing forests. We investigate possible reasons for preferring either to maintain existing forest sites (generally devoted to forestry rather than to conservation or recreation) or to restore nature sites to meet the requirements of the European Commission.

Public preferences are elicited by means of a DCE proposing to convert a coniferous woodland back to heathland (rare habitat) or native broadleaved forest. Our results suggest that respondents are positive about nature restoration projects that involve forest conversion. This noteworthy positive opinion tends to decrease with the size of the clearcut area, which supports prior research findings (Bradshaw, 1992; Tahvanainen et al., 2001). The type of habitat is also influential. The three models converge in showing that a small (50 ha) conversion towards heathland is the most preferred option. This option is also preferred compared to a 50 ha conversion to broadleaf. A medium-sized (100 ha) conversion to broadleaves is on the contrary significantly more appreciated than a medium-sized conversion to heathland. Preferences for larger conversions (200 ha) are not robust across the three models and are consequently hard to interpret.

In the present context, preferences for restoring small patches of heathland may be explained by the original habitat distribution at the site: the proportion of heathland is tiny (3%) compared to coniferous (29%) and broadleaf (35%). In the case of a progressive conversion, we presume that respondents consider a 50 ha conversion to heathland as a priority over other habitat types.

The main reason for this positive opinion is that people tend to value landscape diversity (Geoghegan et al., 1997; Kaplan & Kaplan, 1989). Restoring patches of heathland creates glades in the forest, brings light and makes the forest appear more welcoming to recreationists. Similarly, preferences for converting a 100 ha of conifers to broadleaves reflect the need for diversified forest landscapes. Nielsen, Olsen, and Lundhede (2007) arrive at similar conclusions: respondents value more diverse forest structures. The highest WTP they obtain are for converting even-aged conifer monocultures to mixed stands of conifers, broadleaves and dead trees (creating glades).

Out of the different socio-demographic characteristics that are tested to provide insights on preference heterogeneity, only respondent's age (*Retired*) and membership to a pro-environmental NGO (*Ecofriendly*) are influential. This confirms the findings from Milon and Scrogin (2006). Knowledge and experience of environmental matters help elicit the potential utility gain attached to nature-oriented scenarios, which supports previous findings (Kuckartz & Grunenberg, 2003).

Regarding the influence of the geographical context, our results indicate the presence of a substitution effect. These findings support the assumption that nearby substitutes (5 km neighbourhood) are detrimental to the WTP for restoring nature at a site located further away. As almost all (97.2%) respondents live further than 5 km away from the site, the availability of substitutes is the primary influence. The significance of this perception-based substitution variable may confirm the prevalence of perceived measures over objective measures (Adamowicz et al., 1997). Therefore improving the understanding of the substitution question remains a necessary stage towards more realistic nature valuation.

A potential limitation of our study may come from the small sample size (mainly imputable to budget constraints) combined with the large proportion of incomplete responses. The standard MXL model could contain 258 respondents, but is reduced to 217 respondents to be comparable with the models including socio-demographics. Follow-up questions asked at the end of the survey show that most of the respondents (84.5%) could clearly understand the questions. Since it is not a complexity issue, we suspect a possible fatigue effect. The survey length (15 min) may explain this drop in observations for the socio-demographics (asked after the DCE).

Another limitation may originate from a likely self-selection bias. The proportion of eco-friendly respondents is large (24.4%) and their influence is particularly obvious in the LCM. Class 2 ("Nature enthusiasts") contains about 45% of eco-friendly respondents. WTP estimates for this class are significantly higher than for other classes. As these estimates might reflect an upward bias, one should treat them cautiously.

However, when contrasting the results from the three models, we observe that the WTP estimates remain in the same order of magnitude as those calculated by Liekens et al. (2013) in a similar context. For instance, the mean WTP estimated from the three models for a 100 ha conversion to broadleaves ranges (on average) from €80.2 to €239.8, which is in line with the €182 obtained by Liekens et al. (2013) for a conversion of agricultural lands to forests.

Despite all aforementioned shortcomings, we believe this analysis meets its predefined objectives. This research is carried out in response to a demand from regional planning agencies desperately looking for case studies demonstrating empirical proves of the value attached by Flemish citizens to nature restoration. Considering their similarity with prior valuation results, our findings may be helpful to policy-makers in the preparation of landscape management plans that fulfil the conservation requirements of the European Commission without forgetting about other functions of nature that matter to the public.

8. Conclusion

This study supports previous findings that people are willing to pay to convert coniferous forest plantations to restore higher value nature, such as heathland or broadleaved forest. Public preferences are, however, not straightforward. They rely on site, individual and context-dependent factors. We observe that respondents favour restoration projects that involve limited forest conversion. We confirm that the WTP is highest for maximising landscape diversity by creating small glades within the forest.

These results highlight the important responsibility of policy-makers in accounting for a diversity of opinions when planning nature restoration works. Nature is increasingly valued due to its recreational benefits. Recreation should therefore be central in landscape management decisions. However, preferences for outdoor recreation must be considered together with all of the other functions of natural sites. In densely populated regions, nature represents a scarce and valuable resource that, in essence, serves various aims. Policy-makers should give priority to multi-purpose nature management as it satisfies ecological objectives (e.g. Natura 2000 targets) without compromising all of the other ecosystem services, especially cultural services that support aesthetic, recreational and spiritual values.

Acknowledgments

Data collection was funded by "Regionaal Landschap Meetjesland" and "Agentschap voor Natuur en Bos". We are grateful for the "Marie Curie Actions" mobility grant co-financed by the European Commission and the Belgian Science Policy that allowed for cooperation with Dr. Wendy Chen. Thanks as well to Rik Hendrix for sharing his specific ecological knowledge about the site and to Alistair Beames revising the use of English in this article.

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